<2.9~11절>

2.45 [질점의 평형 문제]

P = 500 N,　α = 60°,　β = 25°,　γ = 45°

<방법 1 : 직각 성분>

$\Sigma F_x = 0$; $-T_1 \cos\gamma + T_2 \cos\beta - P \cos\alpha = 0$

$\Rightarrow$　$-T_1 \cos\gamma + T_2 \cos\beta = P \cos\alpha$　　$\cdots$ ①

$\Sigma F_y = 0$; $T_1 \sin\gamma + T_2 \sin\beta - P \sin\alpha = 0$

$\Rightarrow$　$T_1 \sin\gamma + T_2 \sin\beta = P \sin\alpha$　　　$\cdots$ ②

(a) ①×$\sin\beta$ − ②×$\cos\beta$
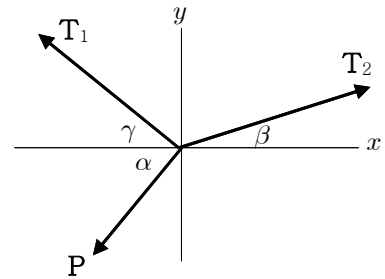
$-T_1 (\cos\gamma \sin\beta + \sin\gamma \cos\beta) = P (\cos\alpha \sin\beta - \sin\alpha \cos\beta)$

$\Rightarrow$　$T_1 = P \dfrac{\sin(\alpha-\beta)}{\sin(\gamma+\beta)} = (500 \text{ N}) \dfrac{\sin(60°-25°)}{\sin(45°+25°)} = 305.2 \text{ N}$　$\Rightarrow$　$T_1 = 305 \text{ N}$

(b) ① $\Rightarrow$　$T_2 = \dfrac{T_1 \cos\gamma + P \cos\alpha}{\cos\beta} = \dfrac{(305.2 \text{ N}) \cos45° + (500 \text{ N}) \cos60°}{\cos25°} = 514.0 \text{ N}$

$\Rightarrow$　$T_2 = 514 \text{ N}$

<방법 2 : 힘 삼각형>

$\theta_1 = 90° - (\alpha+\beta) = 90° - (30°+25°) = 35°$
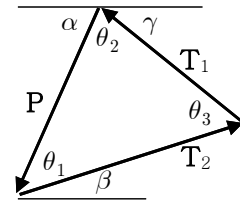
$\theta_2 = 180° - (\alpha+\gamma) = 180° - (60°+45°) = 75°$

$\theta_3 = \beta + \gamma = 25° + 45° = 70°$

(a) $\dfrac{T_1}{\sin\theta_1} = \dfrac{P}{\sin\theta_3}$

$\Rightarrow$ $T_1 = P \dfrac{\sin\theta_1}{\sin\theta_3} = (500 \text{ N}) \dfrac{\sin35°}{\sin70°} = 305.2 \text{ N}$　　　$\Rightarrow$　　$T_1 = 305 \text{ N}$

(b) $\dfrac{T_2}{\sin\theta_2} = \dfrac{P}{\sin\theta_3}$

$\Rightarrow$ $T_2 = P \dfrac{\sin\theta_2}{\sin\theta_3} = (500 \text{ N}) \dfrac{\sin75°}{\sin70°} = 514.0 \text{ N}$　　　$\Rightarrow$　　$T_1 = 514 \text{ N}$

2.55 [질점의 평형 문제]
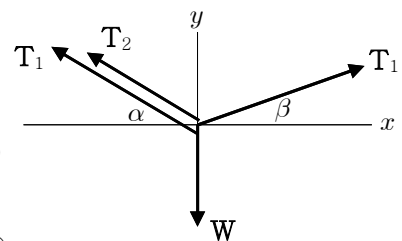
W = 900N,　α = 30°,　β = 10°

<방법 1 : 직각 성분>

$\Sigma F_x = 0$; $T_1 \cos\beta - (T_1 + T_2) \cos\alpha = 0$

$\Rightarrow$　$T_1 (\cos\beta - \cos\alpha) - T_2 \cos\alpha = 0$　$\cdots$ ①

$\Sigma F_y = 0$; $T_1 \sin\beta + (T_1 + T_2) \sin\alpha - W = 0$

$\Rightarrow$　$T_1 (\sin\beta + \sin\alpha) + T_2 \sin\alpha = W$　$\cdots$ ②

(a) ①×$\sin\alpha$ + ②×$\cos\alpha$

$T_1 (\cos\beta - \cos\alpha) \sin\alpha + T_1 (\sin\beta + \sin\alpha) \cos\alpha = W \cos\alpha$

$\Rightarrow$　$T_1 = W \dfrac{\cos\alpha}{\sin\alpha \cos\beta + \cos\alpha \sin\beta} = W \dfrac{\cos\alpha}{\sin(\alpha+\beta)}$

$= (900 \text{ N}) \dfrac{\cos30°}{\sin(30°+10°)} = 1212.6 \text{ N}$　　　$\Rightarrow$　　　$T_1 = 1213 \text{ N}$

(b) ① $\Rightarrow$　$T_2 = T_1 \dfrac{\cos\beta - \cos\alpha}{\cos\alpha} = (1212.6 \text{ N}) \dfrac{\cos10° - \cos30°}{\cos30°} = 166.32 \text{ N}$

$\Rightarrow$　　$T_2 = 166.3 \text{ N}$
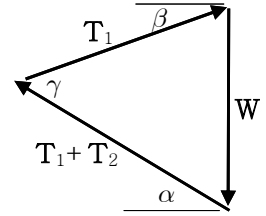
<방법 2 : 힘 삼각형>

$\gamma = \alpha + \beta = 30° + 10° = 40°$

(a) $\dfrac{T_1}{\sin(90° - \alpha)} = \dfrac{W}{\sin\gamma}$

$\Rightarrow \quad T_1 = W\dfrac{\sin(90° - \alpha)}{\sin\gamma} = (900 \text{ N})\dfrac{\sin(90° - 30°)}{\sin 40°}$

$= 1212.6 \text{ N} \qquad \Rightarrow \qquad T_1 = 1213 \text{ N}$

(b) $\dfrac{T_1 + T_2}{\sin(90° - \beta)} = \dfrac{W}{\sin\gamma}$

$\Rightarrow \quad T_1 + T_2 = W\dfrac{\sin(90° - \beta)}{\sin\gamma} = (900 \text{ N})\dfrac{\sin(90° - 10°)}{\sin 40°} = 1378.9 \text{ N}$

$\Rightarrow \quad T_2 = 1378.9 \text{ N} - T_1 = 1378.9 \text{ N} - 1212.6 \text{ N} = 166.3 \text{ N}$

2.63 [질점의 평형 문제]

$W = 200 \text{ N}, \quad h = 400 \text{ mm},$

줄의 장력은 동일 $T = W$
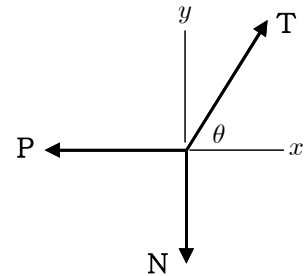
$\theta = \tan^{-1}\dfrac{h}{x}$

<방법 1 : 직각 성분>

$\Sigma F_x = 0 \; ; \; -P + T\cos\theta = 0 \quad \Rightarrow \quad P = T\cos\theta$

(a) $x = 90 \text{ mm}, \quad \theta = \tan^{-1}\dfrac{400 \text{ mm}}{90 \text{ mm}} = 77.3°$

$P = (200 \text{ N})\cos 77.3° = 43.90 \text{ N} \qquad \Rightarrow \qquad P = 43.9 \text{ N}$

(b) $x = 300 \text{ mm}, \quad \theta = \tan^{-1}\dfrac{400 \text{ mm}}{300 \text{ mm}} = \tan^{-1}\dfrac{4}{3}$

$P = (200 \text{ N})\dfrac{3}{5} = 120 \text{ N}$

<방법 2 : 힘 삼각형>

$P = T\cos\theta$

(a) $x = 90 \text{ mm}, \quad \theta = \tan^{-1}\dfrac{400 \text{ mm}}{90 \text{ mm}} = 77.3°$

$P = (200 \text{ N})\cos 77.3° = 43.90 \text{ N} \qquad \Rightarrow \qquad P = 43.9 \text{ N}$

(b) $x = 300 \text{ mm}, \quad \theta = \tan^{-1}\dfrac{400 \text{ mm}}{300 \text{ mm}} = \tan^{-1}\dfrac{4}{3}$

$P = (200 \text{ N})\dfrac{3}{5} = 120 \text{ N}$